Multilane Traffic Flow Modeling Based on Cellular Automata Theory Using High-performance Computer Systems

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Abstract

The paper deals with developing mathematical model for traffic flow simulation on urban road networks. The presented model refers to microscopic approach, i. e. each car is considered separately and is described by its own set of parameters.

The model is based on the cellular automata theory and presents generalization of Nagel-Schreckenberg model to the multilane case [1]. The computational domain is the 2D lattice where two directions correspond to the road length and width. The number of cells in the transverse direction corresponds to the number of lanes. Each cell of the lattice can be either empty or occupied by one vehicle. Such a model allows vehicles to change lanes and to overtake one another. The algorithm of cell state update is formed by two components: lane change (if it is necessary and possible), movement along the road by the rules of N-S model.

Parallelization is based on the domain decomposition (data partitioning) technique and message passing between nodes of the cluster. Each node can process either calculation of certain road fragment (crossroad of any kind or straight part of the road), or some combination of neighboring road fragments. Parallel implementation provides the description of vehicle behavior in details and the real time forecast of big city traffic states.

The program package includes user interface that allows to change road length, number of lanes, traffic lights regime, entering flows and other parameters of computation and some global parameters of the model, and results visualization module, that provides the opportunity to see cars movement during the calculation.

References

1. K. Nagel and M. Schreckenberg. A Cellular Automation Model for Freeway Traffic. J. Phys. I France, Vol.2 p. 2221 (1992).